World Journal of Gastroenterology

Online Submissions: http://www.wjgnet.com/esps/
wjg@wjgnet.com
doi:10.3748/wjg.v19.i34.5732

World J Gastroenterol 2013 September 14; 19(34): 5732-5737
ISSN 1007-9327 (print) ISSN 2219-2840 (online)
© 2013 Baishideng. All rights reserved.

BRIEF ARTICLE

Application value of multi-slice spiral computed tomography for imaging determination of metastatic lymph nodes of gastric cancer

Chun-Lai Dai, Zhi-Gang Yang, Li-Ping Xue, Yu-Mei Li

Chun-Lai Dai, Zhi-Gang Yang, Department of Radiology, the First Hospital of Jilin University, Changchun 130021, Jilin Province, China
Li-Ping Xue, Press of Maternal and Child Health Care of China, Medicine Periodical House of Jilin Province, Changchun 130061, Jilin Province, China
Yu-Mei Li, Department of Pediatrics, the First Hospital of Jilin University, Changchun 130021, Jilin Province, China
Author contributions: Dai CL was in charge of experimental design and carrying out the study; Yang ZG and Xue LP were responsible for image collection and after treatment at the workstation; Li YM took charge of collecting and analyzing data.
Supported by Jilin Provincial Science and Technology Department No. 201015158, No. 20110922; and Jilin Provincial Administration of Traditional Chinese Medicine, No. 2011-JS20
Correspondence to: Yu-Mei Li, MD, Professor, Department of Pediatrics, the First Hospital of Jilin University, Xinmin Street No. 1, Changchun 130021, Jilin Province, China. liyumei1988@126.com
Telephone: +86-431-88783976 Fax: +86-431-88783975
Received: May 27, 2013 Revised: July 29, 2013
Accepted: August 12, 2013
Published online: September 14, 2013

Abstract

AIM: To evaluate the application value of multi-slice spiral computed tomography (MSCT) for imaging determination of metastatic lymph nodes of gastric cancer and to explore reasonable diagnostic criteria.

METHODS: Sixty patients with gastric cancer underwent 64 MSCT scans before operation. Gastric cancer samples and perigastric lymph nodes were obtained after operation, formalin fixation and haematoxylin-eosin staining. The metastatic conditions of gastric cancer and perigastric lymph nodes were determined under a light microscope. A total of 605 lymph nodes were grouped and assessed according to distribution, size, shape and degree of lymph node enhancement. Then, the findings were compared with the postoperative pathological results.

RESULTS: Among 605 lymph nodes, 358 were confirmed as metastatic, accounting for 59.2%. A total of 535 lymph nodes were detected in original axis images combined with multiplanar reconstruction images of MSCT. The metastatic lymph nodes had specific signs in computed tomography. This study showed that the long diameter of lymph nodes $\geqslant$ 8 mm indicated metastasis; the sensitivity and specificity were 79.6% and 78.8%, respectively. The difference of the mean value of lymph node enhancement density $\geqslant$ 80 Hu indicated metastasis; the sensitivity and specificity were 81.6% and 75.6%, respectively. The ratio of short diameter to long diameter of lymph nodes $\geqslant$ 0.7 indicated metastasis; the sensitivity and specificity were 85.6% and 71.8%, respectively.

CONCLUSION: MSCT is a non-invasive and reliable method for preoperative examination of gastric cancer. Sensitivity and specificity for prediction of lymph node metastasis are high.

© 2013 Baishideng. All rights reserved.

Key words: X-ray computer; Gastric cancer; Metastatic lymph nodes

Core tip: Gastric cancer is one of the most common malignant tumours of the digestive system. In recent years, individualised surgical therapy has been applied for gastric cancer. This study plan explored the distribution, size, shape and enhancement characteristics of metastatic lymph nodes. It also provided a basis for determining lymph node metastasis before surgery by retrospectively analyzing multi-slice spiral computed tomography manifestations of lymph nodes of patients with gastric cancer after surgery in the hospital. The

findings were compared with the pathological results.

Dai CL, Yang ZG, Xue LP, Li YM. Application value of multi-slice spiral computed tomography for imaging determination of metastatic lymph nodes of gastric cancer. *World J Gastroenterol* 2013; 19(34): 5732-5737 Available from: URL: http://www.wjgnet.com/1007-9327/full/v19/i34/5732.htm DOI: http://dx.doi.org/10.3748/wjg.v19.i34.5732

INTRODUCTION

Gastric cancer is one of the most common malignant tumours of the digestive system. In recent years, individualised surgical therapy has been applied for gastric cancer. The choice of reasonable surgical methods for different stages of gastric cancer depends on accurate preoperative diagnosis. The traditional diagnostic methods of gastric cancer include gastrofiberscope and barium meal of the upper gastrointestinal tract. However, these two methods have certain limitations in the diagnosis of gastric cancer. They cannot clearly display the gastric wall structure, and their ability to determine the presence or absence of adjacent organ invasion, distant metastasis and lymph node metastasis is limited. Multi-slice spiral computed tomography (MSCT) has been used to conduct TM preoperative staging among many patients with gastric cancer in recent years. Original axial images combined with multiplanar reconstruction (MPR) reorganised images are used to carry out preoperative assessment. The assessment includes the location, extent, depth of invasion of gastric cancer, relationship with adjacent organs and metastasis of abdominal organs. Satisfactory results have been achieved. Research on lymph node metastasis of gastric cancer before surgery has shown that a unified standard for determining lymph node metastasis by MSCT is not available worldwide. Lymph node metastasis is a major metastatic mechanism of gastric cancer. Seto *et al*[1] reported that the rate of lymph node metastasis of early gastric cancer is 5.7%-29.0%, and the rates are 0.0%-6.4% and 9.7%-24.3% for early gastric intramucosal carcinoma and gastric submucosal carcinoma, respectively. Yasuda *et al*[2] showed that the rate of lymph node metastasis of early gastric cancer is 8.9%, and the rates are 2.5% and 17.6% for early gastric intramucosal carcinoma and gastric submucosal carcinoma, respectively. Okusa *et al*[3] proposed the concept of metastatic lymph node ratio (MLR). The results of numerous studies worldwide[4,5] have shown that MLR is one of the independent prognostic factors of survival of patients with gastric cancer, which is closely correlated with the five-year survival rate of patients with gastric cancer. Both the Union for International Cancer Control (UICC) and the Japanese General Rules for Gastric Cancer Study consider that lymph node metastasis is an independent and important factor for predicting the prognosis of patients with gastric cancer[6,7]. To date, radical gastrectomy of gastric cancer with radical lymph node excision adjacent to the stomach has achieved better therapeutic effects in the surgical therapy of gastric cancer[8]. The presence or absence of lymph node metastasis, as well as the degree and extent of metastasis, is directly correlated with the choice of therapeutic methods and prognostic evaluation of patients with gastric cancer, which are primary indices for surgical approach selection. Radical excision of metastatic lymph nodes has important clinical significance and prognostic value in patients with gastric cancer. Radical excision of metastatic lymph nodes may affect the immune function in patients and lead to increased surgical trauma, which cannot improve curative effect. Therefore, confirming the presence or absence of lymph node metastasis of gastric cancer before surgery is important for preoperative staging, formulation of clinical therapeutic schedule and prognosis evaluation[9]. MSCT has the advantages of rapid scanning speed, high resolution ratio and convenient image reconstruction, which can estimate lymph nodes by thin-layer scanning and reconstruction technique and direct clinical staging[10-12]. The standard for determining metastasis of lymph nodes by enhancement characteristics and lymph node size displayed by MSCT is the focus of studies and controversies among many researchers. Too high or too low MSCT staging may appear during clinical application because of different standards of size and morphology of lymph nodes and different sizes of lymph nodes in different positions[13]. Thus, this study plan explored the distribution, size, shape and enhancement characteristics of metastatic lymph nodes. It also provided a basis for determining lymph node metastasis before surgery by retrospectively analyzing MSCT manifestations of lymph nodes of patients with gastric cancer after surgery in the hospital. The findings were compared with the pathological results.

MATERIALS AND METHODS

Objectives

Sixty patients with gastric cancer who were hospitalised in the First Affiliated Hospital of Jilin University and underwent MSCT scanning before operation from February 2010 to October 2011 were included the study. The patients comprised 48 male and 12 female with a mean age of 59.5 years (36-78 years). A total of 51 patients were confirmed to have metastatic lymph nodes of gastric cancer after operation, whereas no metastatic lymph nodes were observed in nine patients. The histopathological types included poorly differentiated adenocarcinoma (39 patients), moderately differentiated tubular adenocarcinoma (17 patients) and signet-ring cell carcinoma (4 patients).

Methods

All the patients were asked to fast for 6-8 h before scanning. They were treated with intramuscular injection of 654-2 (20 mg) and oral administration of warm water 10 min before scanning. The patients were scanned in

supine position using 64-MSCT (Siemens, Germany). Scanning parameters were as follows: spiral collimation, 64 × 0.625; thickness of every layer, 5 mm; interval thickness of every layer, 5 mm; speed of bed movement, 12 mm/s; tube voltage, 120 kV and tube current, 260-320 mAs. During plain, arterial and venous scanning phases, the extent of scanning was from the lower oesophagus to the level of inferior pole of kidney, including the whole gastric area. During equilibrium phase, the extent of scanning was from the diaphragmatic dome to the pelvic cavity. Each scan was performed during a breath hold at the end of inspiration. Anconal venous transfusion of non-ionic contrast medium (OmniPaque 300 or Ultravist 300; 80-100 mL) with high pressure injector was used during the enhanced scanning. The rate of injection was 3.0 mL/s, and the starting times of arterial scanning, venous scanning and equilibrium phases were 25, 35 and 60 s after the beginning of injection. After scanning, the original data were treated with thin-slice reconstruction (1 mm; the interval between two adjacent slices was 1 mm). The images of all patients underwent MPR.

Image analysis

Two doctors with years of experience on abdominal image diagnosis analysed and treated the images. According to anatomic sites, original axis images combined with MPR were applied to observe various indices of lymph nodes, including distribution, number, size, shape and degree of lymph node enhancement.

Evaluation of results

Evaluation criteria of CT signs: The lymph nodes were divided into three groups according to the long diameter: ≥ 5 mm group, ≥ 8 mm group and ≥ 10 mm group. Ten points of non-cystic area in each detected lymph node were randomly selected in MSCT. The mean difference of CT value during venous scanning phase and plain scanning was measured. Then, the lymph nodes were divided into three groups according to the degree of enhancement: the difference of mean value of enhancement density ≥ 100 Hu group, ≥ 80 Hu group and ≥ 40 Hu group. The lymph nodes were divided into two groups according to the ratio of short diameter to long diameter: ≥ 0.5 group and ≥ 0.7 group.

Pathological criteria

Gastric cancer samples and perigastric lymph nodes were obtained after operation, formalin fixation and haematoxylin-eosin staining. The metastatic conditions of gastric cancer and perigastric lymph nodes were determined under a light microscope.

Statistical analysis

All the data were analysed using SPSS17.0 software. *K* test was used to evaluate the consistency of metastatic lymph nodes of gastric cancer between MSCT and postoperative pathological diagnosis. Kappa coefficient within 0.71-1.00, 0.41-0.70 and ≤ 0.4 indicated strong, general and weak consistencies, respectively.

RESULTS

Comparison of different long diameters of lymph nodes displayed by MSCT and postoperative pathological results for determination of lymph node metastasis.

A total of 605 lymph nodes were cleaned up in the operation, among which 358 were diagnosed as metastatic by postoperative pathological examination, accounting for 59.2%. Original axis images combined with MPR images found 535 lymph nodes. The lymph nodes could be analysed and determined with a group of lymph nodes as a unit in MSCT images because the lymph nodes were excised with a group as a unit instead of surgically operated, according to the images. A single lymph node could not be specifically studied. Thus, the ability of MSCT to determine the specificity and sensitivity of lymph nodes could be improved as a whole in the study. The data from the different groups were compared with the pathological results. The consistency of lymph node diameter ≥ 5 mm and the postoperative pathological results was general ($K = 0.464$). The consistency of lymph node diameter ≥ 8 mm and the postoperative pathological results was strong ($K = 0.831$). The consistency of lymph node diameter ≥ 10 mm and the postoperative pathological results was weak ($K = 0.232$) (Table 1).

Comparison of different degrees of lymph node enhancement displayed by MSCT and postoperative pathological results for determination of lymph node metastasis.

The consistency of the difference of the mean value of enhancement density ≥ 80 Hu and the postoperative pathological results was strong ($K = 0.849$). The consistency of the difference of the mean value of enhancement density ≥ 100 Hu and the postoperative pathological results was weak. The consistency of the difference of the mean value of enhancement density ≥ 40 Hu and the postoperative pathological results was weak ($K < 0.40$) (Table 1).

Comparison of different ratios of short diameter to long diameter of lymph nodes displayed by MSCT and postoperative pathological results for determination of lymph node metastasis.

The consistency of the ratio of short diameter to long diameter of lymph nodes ≥ 0.7 and the postoperative pathological results was strong ($K = 0.873$). The consistency of the ratio of short diameter to long diameter of lymph nodes > 0.5 and the postoperative pathological results was general ($K = 0.513$) (Table 1).

The diagnostic criteria of metastatic lymph nodes in MSCT for patients with gastric cancer included long diameter of lymph nodes ≥ 8 mm, the ratio of short diameter to long diameter of lymph nodes ≥ 0.7 and the difference of the mean value of enhancement density ≥ 80 Hu. Compared with the postoperative pathological results, the sensitivities and specificities of MSCT for detection of lymph nodes adjacent to the celiac artery and lesser curvature were 89.4% and 90.3%, respectively. The

Table 1 Comparison of different long diameters of lymph nodes displayed, degrees of lymph node enhancement displayed and ratios of short diameter to long diameter of lymph nodes displayed by multi-slice spiral computed tomography and postoperative pathological results for determination of lymph node metastasis

		Number of lymph nodes detected by MSCT	*K* value	Sensitivity	Specificity
Diameter of lymph nodes	≥ 5 mm	470	0.464	88.5%	60.1%
	≥ 8 mm	317	0.831	79.6%	78.8%
	≥ 10 mm	128	0.232	48.6%	93.5%
Difference of enhancement of lymph nodes	≥ 40 Hu	495	0.397	89.3%	65.5%
	≥ 80 Hu	379	0.849	81.6%	75.6%
	≥ 100 Hu	197	0.335	53.8%	95.5%
Ratio of short diameter to long diameter of lymph nodes	≥ 0.5	447	0.513	94.3%	57.3%
	≥ 0.7	375	0.873	85.6%	71.8%

MSCT: Multi-slice spiral computed tomography.

Table 2 Comparison of sensitivities and specificities of metastatic lymph nodes in different groups displayed by multi-slice spiral computed tomography

Positions of lymph nodes	Specificity	Sensitivity
Right area of cardiac orifice	79.2%	57.8%
Left area of cardiac orifice	81.3%	73.5%
Lesser curvature	79.6%	90.3%
Greater curvature	87.5%	45.0%
Superior area of pylorus	88.1%	76.7%
Inferior area of pylorus	78.0%	81.9%
Adjacent to left gastric artery, common hepatic artery, and arteria coeliaca	83.2%	89.4%

detection rates of lymph nodes in the right area of the cardiac orifice and adjacent to the greater curvature were 57.8% and 45.0%, respectively (Table 2).

DISCUSSION

Tumour-node-metastasis staging system is one of the most commonly used staging systems, and is accepted and maintained by the UICC and the American Joint Committee on Cancer[14]. Lymph node metastasis is a major metastatic pathway of gastric cancer. The metastatic rates of lymph nodes in gastric cancer at early and progressive stages are 10% and 74.8%, respectively[15]. The lymph node size determines the lymph node metastasis. Lymph node diameter > 10 mm is used as one of the criteria to diagnose lymph node metastasis of gastric cancer by MSCT. Some researchers have suggested that the lymph node diameter > 5 mm can be used as a criterion of lymph node metastasis of gastric cancer[16,17]. Dux proposed that all the lymph nodes detected by MSCT could be considered as lymph node metastasis. Some researchers have considered that the short diameter of perigastric lymph nodes > 6 mm or the short diameter of lymph nodes adjacent to the stomach > 8 mm should be regarded as metastasis[18]. Moreover, other researchers believe that determining lymph node metastasis by imaging is not sufficient because the sensitivity of revealing small lymph nodes by imaging is low. This study selected 5, 8 and 10 mm (long diameter of lymph nodes) as threshold values of lymph node metastasis, and then a comparative study was performed. The long lymph node diameter of 8 mm was determined as the threshold value of lymph node metastasis after statistical analysis. Compared with the postoperative pathological results, the sensitivity and specificity were more reasonable.

The degree of lymph node enhancement is an important index to determine lymph node metastasis. The perigastric lymph nodes have a specific blood supply, and this blood supply is abundant when metastasis of lymph nodes occurs. After MSCT enhancement, obvious lymph node enhancement is displayed, but the non-metastatic lymph nodes exhibit absence of enhancement or mild enhancement. Fukuya *et al*[19] posited that high density or peripheral high density and central low density of metastatic lymph nodes of gastric cancer show moderate or obvious enhancement, but non-metastatic lymph nodes show no enhancement or mild enhancement. Some researchers believe that CT value ≥ 25 Hu during plain scanning phase, CT value ≥ 70 Hu during arterial scanning phase or CT value ≥ 80 Hu during venous scanning phase is a criterion of positive lymph nodes, which can significantly improve the diagnostic rate of lymph node metastasis[20,21]. In this study, the consistency of the difference of the mean value of enhancement density ≥ 80 Hu and the postoperative pathological results was strong (K = 0.849). The sensitivity and specificity were 81.6% and 75.6%, respectively. Selecting 80 Hu is recommended to determine the threshold value of metastatic lymph nodes of gastric cancer.

The morphology of lymph nodes displayed by MSCT is also an important index to determine lymph node metastasis. Certain exogenous and expansible growth characteristics are shown in lymph nodes when lymph node metastasis occurs. These characteristics contribute to the round or oval morphology of lymph nodes, and the expansible growth of lymph nodes is not balanced so the margin of metastatic lymph nodes is irregular and appears blurred. Thus, the morphology of lymph nodes is one of the references in determining lymph node metastasis by imaging. Fukuya *et al*[19] posited that the ratio of short diameter to long diameter of lymph node metastasis of gastric cancer was (0.81 ± 0.15), but the ratio of short diameter to long diameter of lymph node metastasis of gastric cancer was (0.57 ± 0.15). This study showed

that the consistency of the ratio of short diameter to long diameter of lymph nodes ≥ 0.7 and the postoperative pathological results was strong (K = 0.873). When the ratio of short diameter to long diameter of lymph node metastasis of gastric cancer ≥ 0.7 was selected as a criterion, the sensitivity and specificity were 85.6% and 71.8%, respectively. This result showed that the ratio of short diameter to long diameter of lymph node metastasis of gastric cancer ≥ 0.7 in MSCT is more reasonable as a criterion.

The detection rate of lymph nodes in MSCT is correlated with the location of lymph nodes. Some studies have reported that the detection rates of MSCT for mesenteric lymph nodes and lymph nodes adjacent to the aorta were the highest, followed by the lymph nodes adjacent to the lesser curvature and celiac artery. The detection rates of MSCT for lymph nodes adjacent to the ligamentum hepatoduodenale and common hepatic artery were relatively low, and the detection rate of MSCT for lymph nodes adjacent to the nidi was low[6]. The statistical results of the study showed that the sensitivities of MSCT for lymph nodes adjacent to the celiac artery and lesser curvature were 89.4% and 90.3%, respectively. However, the detection rates of MSCT for lymph nodes adjacent to the right area of cardiac orifice and greater curvature were relatively low, especially the lymph nodes adjacent to the greater curvature (45.0%). These results were attributed to the lymph nodes adjacent to the lesser curvature, which were near the stomach wall. The lymph nodes showed soft tissue density; after filling the stomach with water, the lymph nodes were easily foiled. The lymph nodes adjacent to the celiac artery were near the vessels, and lymph node enhancement and vascular enhancement were not significantly co-gradient. They were easily distinguished according to density; thus, the sensitivity of lymph nodes adjacent to the celiac artery was high. The perigastric fat content is one of the important factors affecting the detection rate of lymph nodes by MSCT. In this study, the stomachs of the patients were filled after drinking water, thereby reducing the fat adjacent to the greater curvature and surrounding organs. This phenomenon caused the surrounding lymph nodes not to be displayed, which was one of the main reasons for the low detection rate of lymph nodes adjacent to the greater curvature. In addition, the resolution ratio of MSCT for lymph nodes adjacent to the pancreas was relatively low because most of the patients with gastric cancer were elderly. Their pancreas atrophied, showing nodositas. The densities of lymph nodes adjacent to the pancreas during plain scanning and enhancement scanning were similar to the density of pancreatic substance. The lymph nodes were easily diagnosed as swelling lymph nodes, so determining swelling lymph nodes adjacent to the pancreas by MSCT has a certain limitation.

In conclusion, conducting MSCT examination before operation among patients with gastric cancer, as well as observing and measuring the size, degree of enhancement and morphology of lymph nodes, is helpful in determining lymph node metastasis before operation. The results will provide references for staging of gastric cancer before operation and for choosing a therapeutic schedule.

COMMENTS

Background

Lymph node metastasis is the most important metastatic methods of gastric cancer; it is also one of the important factors affecting the prognosis of patients. The presence or absence of lymph node metastasis, as well as the degree and extent of metastasis, is directly correlated with the choice of therapeutic methods and prognostic evaluation of gastric cancer. Considerable studies exist on predicting lymph node metastasis of gastric cancer before surgery by multi-slice spiral computed tomography (MSCT). A number of predictive criteria are available, including distribution, size and enhancement of lymph nodes, but they are not unified and acknowledged diagnostic criteria.

Research frontiers

MSCT is widely used for diagnosis of preoperative staging of gastric cancer, especially 64-row MSCT or above. This method significantly improves the resolution ratio of images, achieves complete accordance of resolution ratios on axial view, coronal view, sagittal view, inclined plane and curved surface, and provides valuable information for displaying metastatic lymph nodes.

Innovations and breakthroughs

This study investigated the enhancement characteristics of metastatic lymph nodes displayed by MSCT and the relationship between the size of lymph nodes and metastasis. This research also determined the effects of different positions of lymph nodes on the detection rate of MSCT and the relationship between morphology of lymph nodes and metastasis. Preoperative MSCT scanning is one of the important tools used to evaluate the prognosis of patients with gastric cancer.

Applications

N-stage and prognostic evaluation of gastric cancer were performed and applied in the First Affiliated Hospital of Jilin University according to the diagnostic criteria of lymph node metastasis of gastric cancer before surgery designed in this study. The accurate rate of preoperative MSCT for evaluation of lymph node metastasis of gastric cancer was high based on the pathological results of more than 60 patients with gastric cancer after surgery.

Peer review

Application value of multi-slice spiral computed tomography for imaging determination of metastatic lymph nodes of gastric cancer. In this article, authors try to evaluate the application value of multi-slice spiral computed tomography for imaging determination of metastatic lymph nodes of gastric cancer and to explore reasonable diagnostic criteria. As is known, MSCT has been used to conduct TM preoperative staging among many patients with gastric cancer in recent years.

REFERENCES

1 **Seto Y**, Shimoyama S, Kitayama J, Mafune K, Kaminishi M, Aikou T, Arai K, Ohta K, Nashimoto A, Honda I, Yamagishi H, Yamamura Y. Lymph node metastasis and preoperative diagnosis of depth of invasion in early gastric cancer. *Gastric Cancer* 2001; **4**: 34-38 [PMID: 11706625 DOI: 10.1007/s101200100014]

2 **Yasuda K**, Shiraishi N, Suematsu T, Yamaguchi K, Adachi Y, Kitano S. Rate of detection of lymph node metastasis is correlated with the depth of submucosal invasion in early stage gastric carcinoma. *Cancer* 1999; **85**: 2119-2123 [PMID: 10326688]

3 **Okusa T**, Nakane Y, Boku T, Takada H, Yamamura M, Hioki K, Yamamoto M. Quantitative analysis of nodal involvement with respect to survival rate after curative gastrectomy for carcinoma. *Surg Gynecol Obstet* 1990; **170**: 488-494 [PMID: 2343364]

4 **Huang CM**, Lin JX, Zheng CH, Li P, Xie JW, Lin BJ, Wang JB. Prognostic impact of metastatic lymph node ratio on

gastric cancer after curative distal gastrectomy. *World J Gastroenterol* 2010; **16**: 2055-2060 [PMID: 20419845 DOI: 10.3748/wjg.v16.i16.2055]
5 **Sun Z**, Xu Y, Li de M, Wang ZN, Zhu GL, Huang BJ, Li K, Xu HM. Log odds of positive lymph nodes: a novel prognostic indicator superior to the number-based and the ratio-based N category for gastric cancer patients with R0 resection. *Cancer* 2010; **116**: 2571-2580 [PMID: 20336791 DOI: 10.1002/cncr.24989]
6 **Zhang M**, Zhu G, Ma Y, Xue Y. Comparison of four staging systems of lymph node metastasis in gastric cancer. *World J Surg* 2009; **33**: 2383-2388 [PMID: 19760313 DOI: 10.1007/s00268-009-0214-0]
7 **Bilici A**, Seker M, Ustaalioglu BB, Yilmaz B, Doventas A, Salepci T, Gumus M. Determining of metastatic lymph node ratio in patients who underwent D2 dissection for gastric cancer. *Med Oncol* 2010; **27**: 975-984 [PMID: 19885750 DOI: 10.1007/S12032-009-9319-4]
8 **Brennan MF**. Lymph-node dissection for gastric cancer. *N Engl J Med* 1999; **340**: 956-958 [PMID: 10089191]
9 **Kunisaki C**, Shimada H, Nomura M, Matsuda G, Otsuka Y, Ono H, Akiyama H. Distribution of lymph node metastasis in gastric carcinoma. *Hepatogastroenterology* 2006; **53**: 468-472 [PMID: 16795994]
10 **Chen CY**, Wu DC, Kang WY, Hsu JS. Staging of gastric cancer with 16-channel MDCT. *Abdom Imaging* 2006; **31**: 514-520 [PMID: 16465577 DOI: 10.1007/s00261-005-0218-7]
11 **Kim AY**, Kim HJ, Ha HK. Gastric cancer by multidetector row CT: preoperative staging. *Abdom Imaging* 2005; **30**: 465-472 [PMID: 15785907 DOI: 10.1007/s00261-004-0273-5]
12 **Lee JH**, Paik YH, Lee JS, Song HJ, Ryu KW, Kim CG, Park SR, Kook MC, Kim YW, Bae JM. Candidates for curative resection in advanced gastric cancer patients who had equivocal para-aortic lymph node metastasis on computed tomographic scan. *Ann Surg Oncol* 2006; **13**: 1163-1167 [PMID: 16952027 DOI: 10.1245/s10434-006-9002-3]
13 **Vorbeck F**, Osterreicher C, Püspök A, Dragosics B, Fiebiger W, Chott A, Raderer M. Comparison of spiral-computed tomography with water-filling of the stomach and endosonography for gastric lymphoma of mucosa-associated lymphoid tissue-type. *Digestion* 2002; **65**: 196-199 [PMID: 12239459 DOI: 10.1159/000063816]
14 **Lee MH**, Choi D, Park MJ, Lee MW. Gastric cancer: imaging and staging with MDCT based on the 7th AJCC guidelines. *Abdom Imaging* 2012; **37**: 531-540 [PMID: 21789552 DOI: 10.1007/S00261-011-9780-3]
15 **Kim JP**, Yu HJ, Lee JH. Results of immunochemo-surgery for gastric carcinoma. *Hepatogastroenterology* 2001; **48**: 1227-1230 [PMID: 11677936]
16 **Kendal WS**. Lymph node-based prognostics: limitations with individualized cancer treatment. *Am J Clin Oncol* 2006; **29**: 298-304 [PMID: 16755184 DOI: 10.1097/01.coc.0000214929.01001.16]
17 **Wei WZ**, Yu JP, Li J, Liu CS, Zheng XH. Evaluation of contrast-enhanced helical hydro-CT in staging gastric cancer. *World J Gastroenterol* 2005; **11**: 4592-4595 [PMID: 16052695]
18 **D'Elia F**, Zingarelli A, Palli D, Grani M. Hydro-dynamic CT preoperative staging of gastric cancer: correlation with pathological findings. A prospective study of 107 cases. *Eur Radiol* 2000; **10**: 1877-1885 [PMID: 11305564]
19 **Fukuya T**, Honda H, Hayashi T, Kaneko K, Tateshi Y, Ro T, Maehara Y, Tanaka M, Tsuneyoshi M, Masuda K. Lymph-node metastases: efficacy for detection with helical CT in patients with gastric cancer. *Radiology* 1995; **197**: 705-711 [PMID: 7480743]
20 **Kwee RM**, Kwee TC. Imaging in assessing lymph node status in gastric cancer. *Gastric Cancer* 2009; **12**: 6-22 [PMID: 19390927 DOI: 10.1007/S10120-008-0492-5]
21 **Espín Alvarez F**, Bianchi Cardona A, Pulido Martínez L, Feliu Canaleta J, Moreno Luna A, Fantova Cosculluela MJ. Value of spiral computed tomography for the preoperative detection of lymph node involvement in gastric cancer. *Med Clin* (*Barc*) 2009; **132**: 214-216 [PMID: 19237004 DOI: 10.1016/j.medcli.2008.04.010]

P- Reviewers Bourstyn E, Cignarelli M, Reinhardt MJ
S- Editor Wang JL **L- Editor** A **E- Editor** Li JY

百世登
Baishideng®

Published by **Baishideng Publishing Group Co., Limited**
Flat C, 23/F., Lucky Plaza,
315-321 Lockhart Road, Wan Chai, Hong Kong, China
Fax: +852-65557188
Telephone: +852-31779906
E-mail: bpgoffice@wjgnet.com
http://www.wjgnet.com

ISSN 1007-9327
9 771007 932045 34>

© 2013 Baishideng. All rights reserved.